

REMARKS

This application is a Rule 1.53(b) continuation application of U.S. Serial No. 09/266,578, filed March 11, 1999, now allowed.

Claims 22 to 26 are pending herein. Claims 1 to 21 have been canceled without prejudice or disclaimer. New claim 22 is directed to an embodiment of the invention described in the specification at page 12, line 23 et seq. More particularly, the claim calls for a low refractive antistatic hardcoat film including a hardcoat layer formed of a plurality of layers. Claims 23 to 26 all depend from claim 22 and are directed to various more specific aspects of the invention.

The specification has been amended in the same manner as in the parent application and to identify the parent application.

Filed herewith is an Information Disclosure Statement listing all references cited during prosecution of the parent application.

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LOW REFLECTIVE ANTISTATIC HARDCOAT FILM

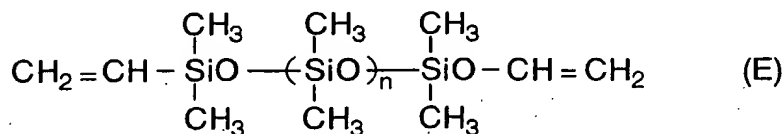
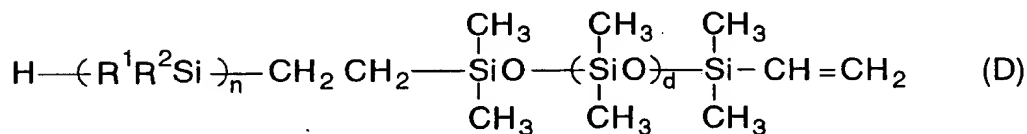
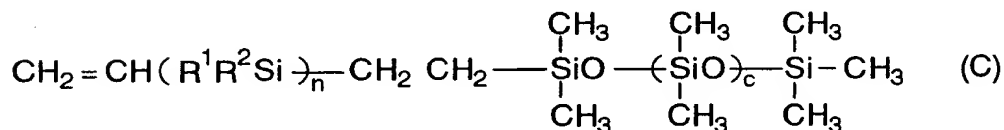
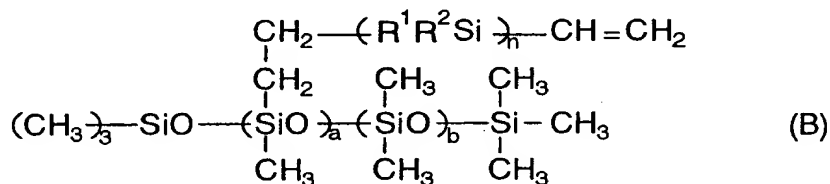
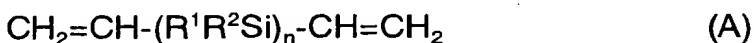
BACKGROUND OF THE INVENTION

The present invention relates to a film that has dust-proof properties and scratch resistance and at the same time can fully prevent surface reflection, and more particularly to a low reflective antistatic transparent film that can prevent soiling created by deposition of dust, on the surface of various displays of word processors, computers, and televisions, surfaces of polarizing plates used in liquid crystal displays, optical lenses, such as sunglass lenses of transparent plastics, lenses of eyeglasses, finder lenses for cameras, covers for various instruments, and surfaces of window glasses of automobiles and electric rail cars, and in addition possesses excellent scratch resistance and can prevent reflection of outdoor daylight from the surface thereof.

Glass, plastic and other transparent substrates are used in ^{curved} mirrors, back mirrors, goggles, and window glasses, particularly displays of electronic equipment, such as personal computers and word processors, and other various commercial displays. Plastic transparent substrates, as compared with glass substrates, are lightweight and less likely to be broken, but on the other hand, they are disadvantageous in that dust is electrostatically deposited on the surface thereof and, in addition, the hardness is so low that the scratch resistance is poor and, hence, scratches created by rubbing, scratching or the like deteriorate the transparency. Further, a problem common to transparent substrates is that viewing of visual information, such as objects, letters, or figures, through transparent substrates, or viewing of images from the reflective layer through the transparent substrate in mirrors causes outdoor daylight to be reflected from the surface of the transparent substrates, making it difficult to view internal visual information.

Conventional methods for preventing the electrostatic deposition of dust and the deterioration in transparency due to scratches in plastic substrates include coating of an antistatic paint on the surface of the plastic substrates and formation of a

containing a plurality of groups capable of being reaction crosslinked upon exposure to an ionizing radiation, for example, polymerizable double bond groups, having a molecular weight of not more than 5,000. This type of reactive organosilicon compounds ^{includes} ~~(include)~~ polysilanes terminated on one end with a vinyl functional group, polysilanes terminated on both ends with a vinyl functional group, polysiloxanes terminated on one end with a vinyl functional group, polysiloxanes terminated on both ends with a vinyl functional group, and vinyl-functional polysilanes or vinyl-functional polysiloxanes obtained by reacting these compounds. Specific examples of reactive organosilicon compounds usable herein include the following compounds.



wherein R¹ and R² each independently represent an alkyl group having 1 to 4 carbon atoms, and a to d and n are each such a number as will bring the molecular weight of the compound to
 5 not more than 5,000.

Other compounds usable herein include (meth)acryloxysilane compounds, such as 3-(meth)acryloxypropyltrimethoxysilane and 3-(meth)acryloxypropylmethyldimethoxysilane.

10 The conductive layer comprising a reaction curing resin composition with conductive fine particles added thereto may be cured by a conventional method for curing an ionizing radiation curing resin, that is, by irradiation with an electron beam or
 15 ultraviolet light. For example, when curing with an electron beam is contemplated, use may be made of electron beams having an energy of 50 to 1000 KeV, preferably 100 to 300 KeV, emitted from various electron beam accelerators, such as Cockcroft-Walton accelerator, van de Graaff accelerator, resonance transformer, insulated core transformer, linear,
 20 dynamitron, and high-frequency electron accelerators. In the case of ultraviolet curing, ultraviolet light emitted from light sources, such as ultrahigh pressure mercury lamps, high pressure mercury lamps, low pressure mercury lamps, carbon arc, xenon arc, and metal halide lamps, may be utilized.

25 Preferably, the transparent conductive layer thus formed has a surface resistivity of not more than $10^{12} \Omega / \square$. The thickness of the conductive layer is generally 0.5 to 6 μm , preferably 1 to 5 μm . When the thickness is less than 0.5 μm , it is difficult to bring the surface resistivity of the conductive
 30 layer provided on the transparent substrate film to not more than $10^{12} \Omega / \square$. On the other hand, when the thickness exceeds 6 μm , the transparency of the conductive layer is sometimes lost.

The hardcoat provided on the transparent conductive layer is a layer that has ^ahardness high enough to withstand
 35 scratching and is not significantly detrimental to the electrical conductivity. The hardcoat may be generally formed by coating. Reaction curing resins, reactive organosilicon compounds and

acrylic resin, epoxy resin, polyamide resin, polyurethane resin and other organic beads that have been surface treated with gold and/or nickel. The average particle diameter of the surface treated organic beads is preferably about 5 μ m.

5 According to the present invention, bringing the refractive index of the hardcoat layer to higher than that of the low refractive layer can further lower~~s~~ the reflectance of the low reflective antistatic hardcoat film of the present invention.

10 The refractive index of the conventional hardcoat layer is about 1.48 to 1.52, while the refractive index of the hardcoat layer according to the present invention is preferably about 1.55 to 2.50. When the hardcoat layer is a high refractive, anisotropic conductive layer, the antistatic properties and the low reflectance of the surface can be further improved.

15 In order to render the hardcoat layer highly refractive, metals having a high refractive index or ultrafine particles of metal oxides may be added to the hardcoat-forming resin component. In the present invention, preferred ultrafine particles having a high refractive index are those having a
20 particle diameter of 1 to 50 nm and a refractive index of about 1.60 to 2.70. Specific examples thereof include impalpable powders of ZnO (refractive index 1.90), TiO₂ (refractive index 2.3 to 2.7), CeO₂ (refractive index 1.95), Sb₂O₅ (refractive index 1.71), SnO₂, ITO (refractive index 1.95), Y₂O₃ (refractive index 1.87),
25 La₂O₃ (refractive index 1.95), ZrO₂ (refractive index 2.05), and Al₂O₃ (refractive index 1.63).

Further, resins containing molecules or atoms as a high refractive component may be added to the reaction curing resin composition for the hardcoat layer. Molecules and atoms usable
30 as the high refractive component include halogen atoms other than fluorine, sulfur, nitrogen, and phosphorus atoms, and aromatic rings. Methods usable for forming a hardcoat using the reaction curing resin composition comprising the above components include one ^{that} [which] comprises dissolving or
35 dispersing the above components in a suitable solvent to form a coating liquid, coating the coating liquid directly on the conductive layer and curing the coating, and one [which] ^{that}

comprises coating the coating liquid onto a release film, curing the coating, and transferring the cured coating onto the conductive layer with the aid of a suitable adhesive. When the formation of the hardcoat layer by the transfer is contemplated, it is possible to use a method ^{that} [which] comprises forming a low refractive layer described below on a release film, forming a hardcoat layer on the low refractive layer, and transferring both the layers onto the conductive layer. The thickness of the hardcoat layer thus formed is generally about 1 to 50 μm , preferably about 3 to 20 μm .

Next, the formation of a low refractive layer on the hardcoat layer provides the low reflective antistatic hardcoat film of the present invention. Methods usable for forming the low refractive layer include a conventional method wherein an about 0.08 to 0.2 μm -thick thin layer of MgF_2 , SiO_x , wherein $1 \leq x \leq 2$, or the like is formed by vacuum deposition or a vapor phase process, such as sputtering or plasma chemical vapor deposition (CVD), and a method wherein an SiO_2 gel film is formed from a sol containing an SiO_2 sol. Further, a film of a low refractive resin, for example, a fluororesin, such as a copolymer of vinylidene fluoride with hexafluoropropylene, or a silicon-containing vinylidene fluoride copolymer may also be formed as the low refractive layer. According to the present invention, a low refractive layer formed of SiO_x , such as SiO_2 , is preferred from the viewpoint of better adhesion to the hardcoat. In order that the antistatic hardcoat film of the present invention has low reflectance, the refractive index of the low refractive layer should be lower than that of the hardcoat, preferably not more than 1.47, more preferably 1.40 to 1.45.

Fig. 2 shows an embodiment wherein fine irregularities are provided on the surface of the antireflective antistatic film to impart antiglare properties to the antireflective film. The fine irregularities may be formed by any conventional method, for example, a method using a matte hardcoating material with inorganic or organic beads dispersed therein, or a method wherein a matte film is used to perform transfer. For example, when the hardcoat is formed by transfer, a method may be used

(which)^{that} comprises providing, as a substrate film for a transfer material, a matte film having fine irregularities on its surface, coating a coating liquid for a hardcoat on the film, curing the coating, and transferring the hardcoat onto the surface of the
 5 conductive layer optionally through an adhesive or the like to impart fine irregularities 5 to the surface of the hardcoat.

Another example of the transfer method comprises coating a coating liquid for a hardcoat on the surface of the conductive layer, drying the coating, applying a matte film as described
 10 above onto the surface of the resin layer, and, in this state, curing the resin layer, followed by separation of the matte film to transfer the fine irregularities of the matte film onto the surface of the hardcoat. In any event, since the low refractive layer provided on the surface of the hardcoat having fine irregularities
 15 is thin, fine irregularities appear on the surface of the low refractive layer.

In the low reflective antistatic hardcoat film according to the present invention, layers for imparting various functions may be additionally provided in addition to the layers described above.
 20 For example, an adhesive layer or a primer layer may be provided in order to improve the adhesion between the transparent substrate film and the hardcoat. Further, the hardcoat may be constituted by a plurality of layers in order to improve the hard properties. The refractive index of the additional layer(s)
 25 provided between the transparent substrate film and the hardcoat is preferably between the refractive index of the transparent substrate film and the refractive index of the hardcoat.

The additional layer may be formed by coating a desired
 30 coating liquid directly or indirectly on the transparent substrate film. When the hardcoat is formed by transfer onto the transparent substrate film, a method may be used (which)^{that} comprises coating a coating liquid for an additional layer (an adhesive layer or the like) onto a hardcoat previously provided on
 35 a release film, laminating the release film having thereon the hardcoat and the additional layer onto a transparent substrate film so that the coating on the release film faces the transparent

Table 2

Evaluation items	Antireflection effect	Antistatic effect	Evaluation of hardness
Ex. 1	○	○	○
Ex. 2	○	○	○
Ex. 3	○	○	○
Ex. 4	○	○	○
Ex. 5	○	○	○
Ex. 6	○	○	○
Ex. 7	○	○	○
Comp. Ex. 1	○	×	○
Comp. Ex. 2	×	○	○
Comp. Ex. 3	×	○	○
Comp. Ex. 4	○	○	×
Comp. Ex. 5	△	○	○

Thus, according to the present invention, a low reflective antistatic film can be provided which, when used in various displays and the like to distinguish visual information, such as objects, letters, and figures through a transparent substrate or when used in viewing an image from a mirror through the transparent substrate from its reflective layer side, can prevent electrostatic deposition of foreign materials on the surface of the transparent substrate, has hardness^{high} enough [high] not to cause a deterioration in transparency due to a scratch created upon being rubbed, and can prevent reflection of outdoor daylight from the surface of the transparent substrate. The above film of the present invention can maintain the transparency on such a level that recognition of images viewed through the film is not hindered.